Allan J. Thompson, Esq.
21 "C" Orinda Way, #314
Orinda, CA 94563
925-258-9962
925-258-9963 (FAX)

June 25, 2004

CALIFORNIA ENERGY COMMISSION
DOCKET UNIT, MS-4
1516 Ninth Street
Sacramento, CA 95814-5512

Re: Docket No. 04-SPPE-01

Enclosed for filing in the above-captioned matter are an original and 12 (twelve) copies of the Riverside Energy Resource Center Small Power Plant Exemption Supplemental Data Response.

Sincerely,

Allan J. Thompson, Esq.
One of Counsel for
City of Riverside Public Utilities

AJT:dmg
Enclosures

**BEFORE THE
ENERGY RESOURCES CONSERVATION
AND DEVELOPMENT COMMISSION
OF THE STATE OF CALIFORNIA**

APPLICATION FOR CERTIFICATION FOR THE RIVERSIDE ENERGY RESOURCE CENTER PROJECT	))))	**Docket No. 04-SPPE-01**

PROOF OF SERVICE

I, Diane M. Gilcrest, declare that on June 25, 2004 I deposited copies of the attached **Riverside Energy Resource Center Small Power Plant Exemption Supplemental Data Response** in the United States mail in Walnut Creek, CA with first class postage thereon fully prepaid and addressed to the following:

DOCKET UNIT

CALIFORNIA ENERGY
COMMISSION
Attn: Docket No. 04-SPPE-01
DOCKET UNIT, MS-4
1516 Ninth Street
Sacramento, CA 95814-5512

APPLICANT

Stephen H. Badgett
Utilities Assistant Director
Riverside Public Utilities
3900 Main Street
Riverside, CA 92522

Robert B. Gill
Principal Electrical Engineer
Riverside Public Utilities
3900 Main Street
Riverside, CA 92522

Dave Tateosian, P.E.
Project Manager
Power Engineers, Inc.
P.O. Box 2037
Martinez, CA 94553

Kevin L. Lincoln
Environmental Project Manager
Power Engineers, Inc.
3940 Glenbrook Drive, Box 1066
Hailey, Idaho 83333

ATTORNEY FOR APPLICANT

Allan J. Thompson, Esq.
21 "C" Orinda Way, #314
Orinda, CA 94563

INTERVENORS

California Unions for Reliable Energy
Marc D. Joseph
Adams, Broadwell, Joseph & Cardozo
651 Gateway Boulevard, Suite 900
South San Francisco, CA 94080

INTERESTED AGENCIES

Kate Kramer
CA Department of Fish and Game
4775 Bird Farm Road
Chino Hills, CA 91709

Milasol Gaslan
Santa Ana Regional Water
Quality Control Board
3737 Main Street, Suite 500
Riverside, CA 92501

John Yee and Ken Coats
South Coast Air Quality
Management District
21865 E. Copley Drive
Diamond Bar, CA 91765-4182

Guenther Moskat, Chief
Planning and Environmental
Analysis Section
Department of Toxic and Substance
Control
1001 "I" Street, 22nd Floor
P. O. Box 806
Sacramento, CA 95812-0806

Mr. R. Austin Wiswell, Chief
Division of Aeronautics
Department of Transportation
1120 N Street, MS 40
Sacramento, CA 94273-0001

I declare under penalty of perjury that the foregoing is true and correct.

Diane M Gilcrest
Diane M. Gilcrest

RIVERSIDE ENERGY RESOURCE CENTER
SMALL POWER PLANT EXEMPTION
SUPPLEMENTAL DATA RESPONSE
04-SPPE-01

Technical Area: Visual Resources

Request: Please provide a CD of KOP 1, 2, and 3.

Response: The CD was sent directly to Dr. Reede on 6-23-04.

Technical Area: Biological Resources

Request: Please notify the CEC when the Western Riverside County Multi-Species Habitat Conservation Plan (WRC MSHCP) is approved.

Response: On Tuesday 22 June 2004 at about 11:00am, the 10(a) permit from the U.S.Fish and Wildlife Service (the Service) and the Section 2081 permit from the California Department of Fish and Game (the Department) were signed in Sacramento by Mr. Jim Bartel of the Service and Mr. Ron Remple of the Department. This information was verified with two sources, including staff of the Western Riverside County Regional Conservation Authority and the California Department of Fish and Game.

Request: Please fax actual line spacing with dimensions.

Response: The typical tangent and deadend structure diagrams with vertical and horizontal dimensions were faxed to Dr. Reede on 6-23-04. PDF files were sent via e-mail on 6-24. Hard copies of those diagrams are attached to this response.

Technical Area: Water Resources

Request: The permeability rate of 1.9 minutes/inch provided in Data Response #49 seems too high. Please explain.

Response: The test procedure and results for the percolation test are covered in the geotechnical report. The range of observations during the percolation test was from 0.34 to 1.9 minutes per inch. The test was conducted in an 8-inch borehole (Area = 0.35 sf). This range results in percolation rates from approximately 470 gpd/sf to 2552 gpd/sf. Selecting a value in the middle of the range gives 1000 gpd/sf. The geotechnical engineer then used a Factor of Safety of 5 and came up with a value of 200 gpd/sf.

Request: Please explain why a runoff coefficient of 0.30 was used.

Response: The selection of 0.3 as a runoff coefficient for gravel surfaces is a typical value supported by the literature. The value was taken from Table 21.15 from the "Standard Handbook for Civil Engineers", Fouth Edition, 1995, Merritt, Loftin and Ricketts. Table 21.15 gives a range of runoff coefficients for railroad yards as 0.2 to 0.3. Railroad yards are typically gravel surfaces and therefore, the selection of this category for gravel surfaces in an industrial setting is appropriate. The value of 0.3 was taken from the middle of the range.

Request: Please provide a "Will Serve" letter from the Water Quality Control Plant.

Response: The "Will Serve" letter will be provided to the CEC by June 30.

Request: Please provide a description of the ZLD options being considered for the project. (DR#57)

Response: We will be utilizing a ZLD (zero liquid discharge) system for this project. We are currently evaluating the various options for ZLD as described below. There are three primary criteria that the selected ZLD system must satisfy:

- Sized to meet the requirements of Units 1 and 2
- Not utilizing a combustion source (such as gas fired equipment) that would contribute to air emissions
- Have been previously reviewed by the CEC as part of another plant's application (such as Aquatech, US Filter, and GE Glegg)

The ZLD system will receive plant process wastewater streams (largely composed of demineralized water treatment system reject water and the combustion turbine chiller cooling tower blowdown) from the plant's wastewater storage tank. The ZLD system will process the water in order to reduce the volume of the waste stream and recover the majority of the water for reuse on-site as plant process makeup. The resulting waste stream will be properly disposed of in an approved disposal facility. As a result, the ZLD system will eliminate process wastewater discharge to City of Riverside sanitary sewer system and will reduce the raw water requirements for the project. We still propose to discharge other sources of wastewater (from sinks, toilets, showers, etc.) to the sanitary sewer system at the adjacent City of Riverside Water Quality Control Plant. The volume of these conventional wastewater sources will be low and no significant impacts are expected.

There are three available ZLD technologies that can achieve the same goal of enabling the Riverside Energy Resource Center to be a ZLD facility. The various options have potentially different cost impacts. Further the cost of disposal of the waste can vary significantly depending on the waste product's form and liquid content. The process waste streams will be collected in a wastewater storage tank.

- Option-1: Brine Concentrator and Spray Dryer

  Wastewater from the storage tank will be fed to a brine concentrator and a spray dryer system. The brine concentrator process will be used to concentrate and evaporate the wastewater. Recovered distilled water from the brine concentrator will be sent to the raw water storage tank for reuse as plant process water makeup. The small amount of highly concentrated brine solution will be sent to an electrically heated spray dryer where the final wastewater will be evaporated leaving a dry solid suitable for off site landfill disposal.

- Option-2: High Efficiency Reverse Osmosis and Crystallizer

  Wastewater from the storage tank will be fed to a conventional water softener followed by a high efficiency reverse osmosis (RO) unit and then finally to a crystallizer. The water softener reduces the hardness and the alkalinity in the water upstream of the RO unit, which maximizes the overall efficiency of the RO unit, thereby reducing the amount of wastewater to be treated in the final crystallizer. The final waste product will be a low volume highly concentrated brine solution that can be trucked off site for landfill disposal.

- Option-3: High Efficiency Reverse Osmosis with Crystallizer and Filter Press

  This option is identical to Option 2, except the crystallizer effluent is further processed in a commercial filter press to produce a low moisture content salt cake. The recovered water from the cake press is returned to the crystallizer. The final cake is tucked off site for landfill disposal.

All of the ZLD technologies outlined above achieve the environmentally responsible goals of reducing the volume of the waste discharge from the plant and conserving/reusing water. In choosing the specific technology to be used for the Riverside Energy Resource Center project, we will consider installed capital costs, long-term operating and maintenance costs, and waste disposal costs in order to achieve the best value for the City and its residents.

Technical Area: Transmission System Engineering

Request: Please provide complete N-1 and N-0 power flow diagrams.

Response: These diagrams are being submitted under confidential cover.

Technical Area: Geology and Paleontology

Request: Please provide CURE with a copy of the Geotechnical Report.

Response: The Geotechnical Report was sent to CURE on 6-22-04.

Technical Area: Cultural Resources

Request: Please identify City of Riverside cultural resources ordinances, and describe how the project will comply with them. (DR #27)

Response: Riverside's commitment to historic preservation began in 1969 with the adoption of a preservation ordinance (*Title 20 of the Municipal Code*) and creation of the Cultural Heritage Board. Title 20 is the primary body of local laws relating to historic preservation and essentially provides guidance on the City's cultural resources program process. The ordinance contains provisions for surveying, recording and designating historic resources; provides historic district design guidelines; and includes an award-winning historic resources inventory data-base; educational programs and a historic preservation plan. Web Site: www.riversideca.gov/planning/historic.htm.

The purpose of Title 20 (Section 20.05.010) of the Municipal Code is to ". . . promote the public health, safety and general welfare by providing for the identification, protection . . . and use of improvements, buildings, structures . . . having special historical, archaeological, cultural, architectural, community, aesthetic or artistic value in the City..." Subsection H. of the Purpose states that one of the reason for this is to ". . . identify as early as possible and resolve conflicts between the preservation of cultural resources and alternative land use."

Per Title 20 and in the spirit of its language, SWCA conducted a cultural resources survey of the project area's Area of Potential Effect for the purpose of identifying and taking into account, before and during the proposed project, any significant cultural resources that could potentially suffer an adverse effect as a result of the proposed Riverside Energy Resource Center project and to make a reasonable and good faith effort to resolve any conflicts that may result.

Request: Please contact the City and County of Riverside to determine whether they have identified any cultural resources within one mile of the project. (DR#29)

SWCA contacted the following government specialists regarding the presence of cultural resources within one mile of the project area:

- City of Riverside, Janet Hansen, Historic Preservation Specialist
- County of Riverside, Cindy Thomack, Historic Preservation Officer

Janet Hansen, Historic Preservation Specialist at the City of Riverside, suggested researching the City's Historic Resources Inventory Data Base on the City of Riverside Web Site: **http://olmsted.riversideca.gov/historic_resources/main.aspx**. The database must be searched by address, style, builder, name, type, etc., but it is not possible to search by street or area. Of the ten historic properties recorded as a result of SWCA's literature review and pedestrian survey, only four properties (5746, 5868 and 5876 Jurupa Avenue and 6019 Florence Street) appear on the list. Neither the Wastewater Treatment Facility, Marth-McLean Anza Narrows Park or Union Pacific Railroad Bridge are listed. This information strengthens SWCA's contention that all properties older than 45 years were identified and recorded as a result of the pedestrian survey.

Cindy Thomack at the County of Riverside searched her files for evidence of cultural resources near the project area. No properties were within the Area of Potential Effect of the project. According to Ms. Tomack a historic properties survey of portions of the County was undertaken in the early 1980s. The survey was accomplished mostly by volunteers under the supervision of a County historian. The record is incomplete, as properties were missed by the survey, and properties not old enough for listing at the time, may have now become eligible.

Request: Please review the ROC dated 6-15-04 from Dorothy Torres and respond.

Response: The applicant is preparing a Technical Report and supporting documentation and mapping in response to the ROC. In a second ROC dated 6-22-04, staff agreed that all the previously requested information could be provided in one report in ARMR format. This report is expected to be complete on July 1.

Request: Please provide the location of the reclaimed water line tie-in to the plant. (DR#38)

Request: According to conversations with Water Quality Control Plant (WQCP) personnel, the reclaimed water for the RERC will be tied-in to a line that is less than 5 years old. Although the exact coordinates of this tie-in are not yet known, it will occur in the area just outside the west boundary of the RERC and a little north of the existing WQCP parking lot.

Request: Please provide the actual age of the transmission lines to be replaced. (DR#25)

Request: The age of the transmission lines are listed below.

Riverside Energy Resource Center
Pole Inventory along Existing Route

Street Name	Pole Count Number	Pole Number	Year of Installation (19__)
Payton Ave.	1	661931H	56
Payton Ave.	2	661930H	56
Payton Ave.	3	661929H	56
Payton Ave.	4	15598J	56
Payton Ave.	5	31932J	72
Payton Ave.	6	J36555	95
Jurupa Ave.	7	J34188	85
Jurupa Ave.	8	33665J	79
Jurupa Ave.	9	33664J	79
Jurupa Ave.	10	33663J	79
Jurupa Ave.	11	33662J	79
Jurupa Ave.	12	33660J	79
Jurupa Ave.	13	18419J	62
Jurupa Ave.	14	18418J	61
Jurupa Ave.	15	18417J	61
Jurupa Ave.	16	18416J	62
Jurupa Ave.	17	18415J	62
Jurupa Ave.	18	18414J	62
Jurupa Ave.	19	J38176	2003
Jurupa Ave.	20	17699J	62
Jurupa Ave.	21	17698J	62
Jurupa Ave.	22	17697J	62
Jurupa Ave.	23	17696J	62
Jurupa Ave.	24	17694J	62
Jurupa Ave.	25	17693J	62
Jurupa Ave.	26	33658J	79
Jurupa Ave.	27	33657J	79
Jurupa Ave.	28	33656J	79
Jurupa Ave.	29	33655J	79
Jurupa Ave.	30	J36553	95
Jurupa Ave.	31	J36552	95
Jurupa Ave.	32	33652J	79
Jurupa Ave.	33	J34556	87

Jurupa Ave.	34	J36551	95
Jurupa Ave.	35	7193J	54
Jurupa Ave.	36	24876J	71
Jurupa Ave.	37	24877J	71
Jurupa Ave.	38	J36302	94
Jurupa Ave.	39	J36548	95
Jurupa Ave.	40	J36547	95
Jurupa Ave.	41	33446J	78
Jurupa Ave.	42	33445J	78
Jurupa Ave.	43	33444J	78
Jurupa Ave.	44	J36546	95
Jurupa Ave.	45	J36545	95
Jurupa Ave.	46	J36544	95
Jurupa Ave.	47	J36543	95
Jurupa Ave.	48	J36542	95
Sheppard St.	49	33494J	80
Sheppard St.	50	33493J	80
Sheppard St.	51	33903J	82

Technical Area: Air Quality

Request: Please revise data response 17 to include a timeline and location.

Response: Please see the table below.

RERC NOx Offset Credits

Amount of NOx Emission Offsets	Issue Date	Expiration Date	Source	Generation
9,500 lb Inland	1/1/05 and every year after	12/31/05 and every year after	Intermetro Industries 9393 Arrow Route Rancho Cucamonga, CA Facility 5830 (909) 987-4731	Facility Shutdown – 3/30/04
4,000 lb Inland	7/1/05 and every year after	6/30/06 and every year after	Pomona Paper Co. 1404 W. Holt Ave. Pomona, CA Facility 117151	Facility Shutdown – 10/30/02

2,000 lb Coastal	1/1/05 and every year after	12/31/05 and every year after	West Newport Oil 1080 W. 17th Costa Mesa, CA. Facility 42775 (949) 631-1100	Process Change – Complete
4,846 lb Coastal	7/1/05 and every year after	6/30/06 and every year after	Mission Dye 905 E. 8th St. Los Angeles, CA 90021 (213) 236-9780	Facility Shutdown – Complete
1,000 lb Coastal	1/1/05	12/31/05	Purchased through Calpine – source is being investigated but credits were previously pooled and transferred in a blind auction.	Reason for generation is being investigated but credits were previously pooled and transferred in a blind auction.
18,500 lb Coastal	1/1/05	12/31/05	Purchased through Calpine – source is being investigated but credits were previously pooled and transferred in a blind auction.	Reason for generation is being investigated but credits were previously pooled and transferred in a blind auction.

Request: Please provide Will Walters with a new modeling CD.

Response: Will received the replacement data files via email after the workshop on June 17th.

Request: Please identify sensitive receptors within 6 miles of the proposed project. This listing shall at minimum include the addresses of schools, hospitals, senior citizen facilities, and day care centers together with their respective distances from the project site. (DR#20)

Response: This information will be provided to the CEC by June 30.

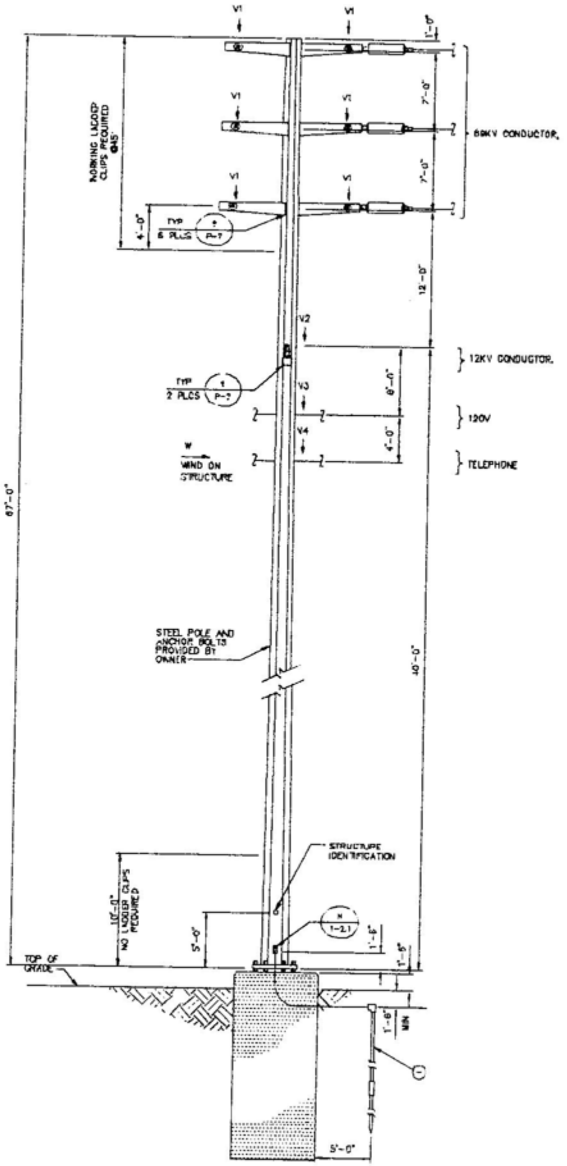
Technical Area: Traffic and Transportation

Request: Please provide a description of the thermal plumes resulting from project operation. (DR#61)

Response: The thermal plume analysis is attached.

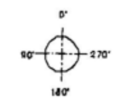
BIOLOGICAL RESOURCES

Typical Tangent and Deadend Structure Diagrams with Vertical and Horizontal Dimensions

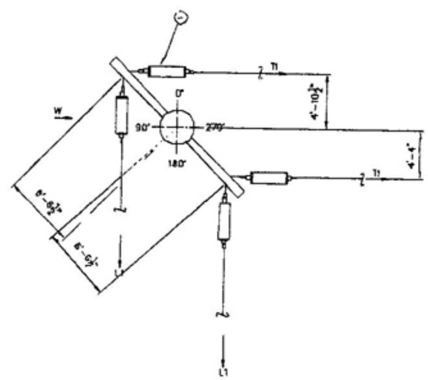


STRUCTURE ELEVATION

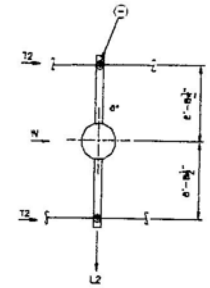
NO SCALE



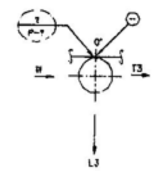
ORIENTATION DIAGRAM PLAN



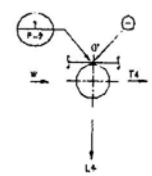
69KV CONDUCTOR PLAN



12KV CONDUCTOR PLAN



120V PLAN



TELEPHONE PLAN

NO	DATE	REVISIONS AND RECORD OF ISSUE	BY	CHK	APP
0	10/25/94	NEW DRAWING	RJC		

BLACK & VEATCH

CITY OF RIVERSIDE, CALIFORNIA
ELECTRIC UTILITY

69KV STEEL DEADEND STRUCTURE
POLE 2

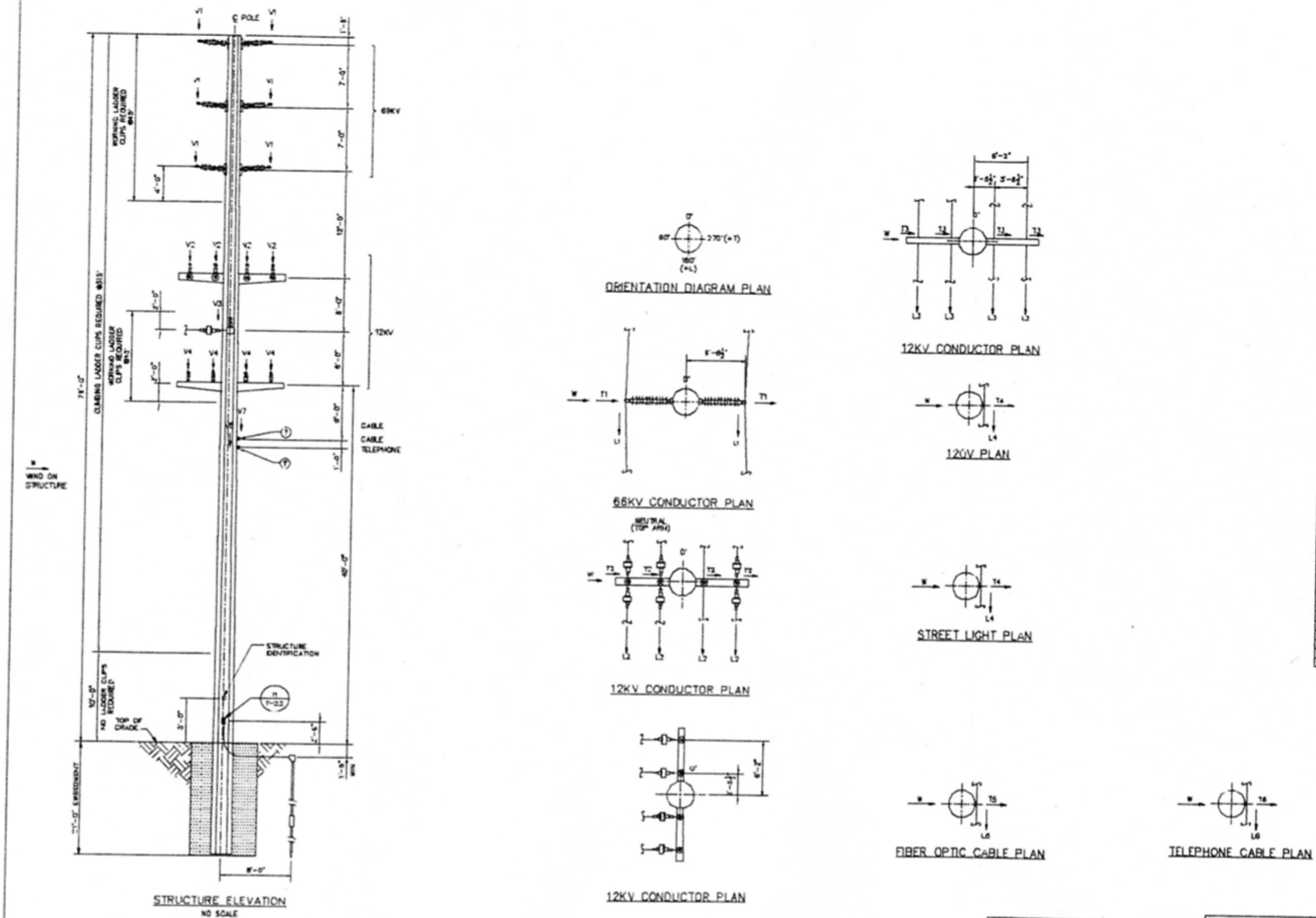
DESIGNED	RJC	DRAWN	TDC
CHECKED	AQR	DATE	10/26/94

PROJECT | DRAWING NUMBER P-2 | REV 0

CODE

AREA

13309D.ARK AD1 ACAD 12_c3
A0TSL006 D1 64
8/5/98 9:03a P.E



STRUCTURE LIST

NEW POLE #	POLE HEIGHT	EMBEDMENT HEIGHT
22	68	11'
23	68	11'
28	68	11'
29	68	11'
30	68	11'
31	68	11'
32	73	11'
33	73	11'
34	73	11'
[illegible]	73	11'
[illegible]	73	11'
37	73	11'
40	73	11'
42	75	11'
43	75	11'
44	75	11'

REV	DESCRIPTION	DR	CHK	APP	DATE
0	NEW DRAWING	JEF		GNE	

JURUPA 69KV TRANSMISSION LINE

SCALE N.T.S. — DRAWN JEF — APPROVED GNE

CITY OF RIVERSIDE
DEPARTMENT OF PUBLIC UTILITIES

DRAWING NO. P-22

REV. 0

TRAFFIC AND TRANSPORTATION

Thermal Plume Analysis

TECHNICAL MEMORANDUM

TO:	John Baker Power Engineers, Inc	**DATE:**	June 23, 2004
FROM:	Howard Balentine, CCM	**FILE:**	08709-294
RE:	CEC 04-SPPE-O1 Data Request 61	**CC:**	

Subject: Thermal Plume Analysis for the Riverside Energy Resource Center

DATA REQUEST

Riverside Energy Resource Center
Data Requests
(04-SPPE-O1)

Technical Area: Traffic and Transportation
Author: David Flores

BACKGROUND

Page 117 of the Small Power Plant Exemption Application states that the Riverside Municipal Airport is approximately .5 miles to the south of the proposed Riverside Energy Resource Center project site. The Riverside Municipal Airport is a city maintained and operated facility. The Airport is a general aviation facility that services the Los Angeles/Riverside areas as a reliever airport. The airport maintains a 5,400-foot x 100-foot runway and a 2,851-foot x 48-foot runway that allow it to handle general aviation and business/corporate jets. The airport has been approved by the Federal Aviation Administration (FAA) for instrument approach landings, and therefore requires a substantial clearance area above tall structures, including transmission line towers.

DATA REQUEST

61. Provide a detailed discussion of the height, length, width and seasonal occurrence of any visible or thermal plumes that may be generated by the proposed facility into the airspace.

RESPONSE

Data Request 61 covers both visible plume and thermal plume impacts that may be generated by the proposed Riverside Energy Resource Center (ERC) facility. The analysis presented in this memorandum addresses only the thermal plume issue raised by the CEC staff. A separate response provided by the Applicant addresses the potential for visual plumes produced by the Riverside ERC to affect aircraft operations.

Summary

The proposed Riverside ERC will be located approximately 100 meters west and 230 meters north of the northern end of runway 16/34 at the Riverside Municipal Airport (KRAL). As part of the California Energy Commission (CEC) licensing process for the Riverside ERC, the CEC, Federal Aviation Administration (FAA), and Airport Land Use Commission staff asked for further information on the potential adverse impact on aircraft operations posed by turbulence in the combustion turbine generator (CTG) exhaust plumes of the Riverside ERC.

Based upon four lines of reasoning presented below, ENSR concludes that exhaust thermal plumes from the Riverside ERC do not pose a significant threat to aircraft operations at the Riverside Municipal Airport. The four lines of reasoning are:

- Turbulence generated by the exhaust plumes are comparable (or less) in magnitude than that of the naturally occurring convective thermal plumes and dust devils common in Riverside County in the summer.
- By the time a plume from the Riverside ERC drifts over the northern extension of Runway 16/34, turbulence in the plume will be essentially indistinguishable from turbulence in the surrounding ambient air.
- Because of the relatively small diameter of the exhaust plumes close to the stack, the time for an aircraft to pass through the plume is very brief, resulting in little opportunity for plume turbulence to affect an aircraft substantially.
- Sampling of power plant plumes by aircraft has occurred safely on numerous occasions during air pollution research studies.

Background

The Riverside ERC will be composed of two General Electric LM6000 simple-cycle natural gas fired combustion turbine generators (CTGs). The plant will be a peaking plant that will operate from May through October only. The stack exhaust parameters for a single LM6000 CTG are given in Table 1 for two different stack exit mass flow rates at 100 percent load. The exit velocities and exit temperatures[1] given in Table 1 bracket the expected range of exhaust conditions for the CTGs for the range of operating and meteorological conditions expected for the facility. The results of this plume analysis are not sensitive to the variation in stack parameters given in Table 1.

[1] The Briggs 1975 plume rise equation is dependent on the stack diameter, exit velocity, and temperature and not the mass flow.

Upon release, each plume will rise vertically due to the vertical momentum of the exhaust gases and their buoyancy. As they rise, the plumes entrain ambient air which results in expansion and cooling of the plumes and the dissipation of their vertical momentum. In the initial stages of plume rise, turbulence in the plume itself is primarily responsible for the entrainment of ambient air and the resultant growth of the plume.

Table 1
Stack Exhaust Parameters for Riverside ERC GE LM6000 CTG

Stack Mass Flow (lb/hr)	Stack Height (ft)	Stack Diameter (ft)	Exit Velocity (ft/s)	Exhaust Temp (F)
1,113,739	80	13	77	826
1,112,884	80	13	73	791

Stack parameters are for 100 percent load conditions.

Once the initial vertical momentum is dissipated, the vertical plume becomes bent over as the ambient wind blows the plume downwind. The plume is still warmer than its surroundings and so continues to rise due to its buoyancy. At this stage, ambient turbulence, as opposed to internal plume turbulence, is responsible for the continued growth of the plume. During this phase of plume rise, the turbulence in the plume is indistinguishable from ambient turbulence. Eventually, the buoyancy of the plume is dissipated due to mixing with ambient air and the rise of the plume stops.

Meteorological Conditions Examined

The proposed Riverside ERC is a peaking plant that will operate typically during the daytime between the months of May and October. Based on meteorological data from the Riverside Citrus Experimental Station cooperative meteorological measurement site, the average temperature during May through October is 72°F with absolute maximum and minimum temperatures of 113°F and 32°F, respectively. Average wind speeds for the Riverside area were determined from the South Coast Air Quality Management District (SCAQMD) Rubidoux monitoring site. For daytime unstable conditions, the average wind speed ranges from 3.7 miles per hour (mph) for very unstable (stability class A) to 5.7 mph for slightly unstable (stability class C) stability conditions.

The plume rise analysis is not sensitive to the ambient temperature range but is sensitive to the ambient wind speed as the plume rise is inversely proportional to the assumed wind speed. As the wind speed increases, turbulence in a plume is dissipated more quickly and the plume rises to a lower final height. This analysis is conservative in that it assumes an average daytime speed of 4 mph.

Plume Rise Computations

Estimates of plume rise of the Riverside ERC stacks were prepared using the Briggs' 1975 plume rise formula (Briggs, 1975a) for unstable conditions, as implemented in the Environmental Protection Agency Industrial Source Complex Short Term, Version 3 (ISCST3) dispersion model (EPA, 1997).

Following the Briggs methodology, the Riverside ERC plumes are momentum-dominated for the first few seconds of release, after which they transition to buoyancy-domination for the rest of the plume rise. When a plume is momentum-dominated, plume rise is governed primarily by the momentum of the plume on release and turbulence within the plume is produced mainly by shear between the upward directed plume and horizontal wind flow. Once the plume transitions to buoyancy domination, plume turbulence is governed by shear produced by the thermal buoyancy of the plume with respect to the surrounding air and by the ambient turbulence levels. The peak turbulence intensities in a plume occur during the momentum-dominated phase of plume rise. For the purposes of this analysis, it is assumed that the peak potential hazard to aircraft will occur in the momentum dominated phase of vertical plume rise where the turbulence is due to shear between the internal vertical plume motion and the horizontal ambient wind flow. Once the plume becomes buoyancy-dominated and eventually bends over, the turbulence in the plume becomes essentially that of the ambient air.

Under a typical wind speed of 4 mph (1.8 meters/second) for the Riverside area, the final (maximum) plume rise for a single plume is approximately 950 meters (including the height of the stack). Under calm wind speed conditions, the plume will transition from momentum-domination to buoyancy-domination at a height above the ground of approximately 67 meters. This transition height will be lower for the typical wind speed of 4 mph for the Riverside area under unstable daytime conditions. Table 2 presents estimated plume height and growth as a function of downwind distance for the momentum-dominated phase of plume rise. Figure 1 presents a plot of plume height and plume radius as a function of time since release out to 70 seconds.

The two CTG stacks are spaced 38 m (125 ft) apart. As half this spacing (19 m) is significantly more than the radii of the exhaust plumes given in Table 2, the plumes from the two individual stacks are not expected to interact or merge while in the initial momentum dominated phase of plume rise.

Table 2
Plume Height and Growth as a Function of Time and Downwind Distance

Downwind Distance (m)	Elapsed Time (sec)	Plume Height (m)	Plume Radius (m)	Vertical Entrainment Velocity ($\Delta z/\Delta t$) (m/s)	Radial Entrainment Velocity ($\Delta r/\Delta t$) (m/s)
1	0.6	31.7	3.1	13.0	1.95
2	1.1	35.9	3.7	7.6	1.15
3	1.7	39.5	4.3	6.4	0.96
4	2.2	42.7	4.7	5.7	0.86
5	2.8	45.7	5.2	5.3	0.79
6	3.4	48.4	5.6	4.9	0.74
7	3.9	51.0	6.0	4.7	0.70
8	4.5	53.5	6.3	4.4	0.67
9	5.0	55.9	6.7	4.3	0.64
10	5.6	58.2	7.1	4.1	0.61
11	6.2	60.4	7.4	4.0	0.59
12	6.7	62.5	7.7	3.8	0.58
13	7.3	64.6	8.0	3.7	0.56
14	7.8	66.7	8.3	3.6	0.55
15	8.4	68.7	8.6	3.6	0.53
16	8.9	70.6	8.9	3.5	0.52
17	9.5	72.5	9.2	3.4	0.51
18	10.1	74.4	9.5	3.3	0.50
19	10.6	76.2	9.8	3.3	0.49
20	11.2	78.0	10.0	3.2	0.48
21	11.7	79.8	10.3	3.2	0.48
22	12.3	81.5	10.6	3.1	0.47

Note: Plume rise computed for unstable conditions for a wind speed of 4 mph.

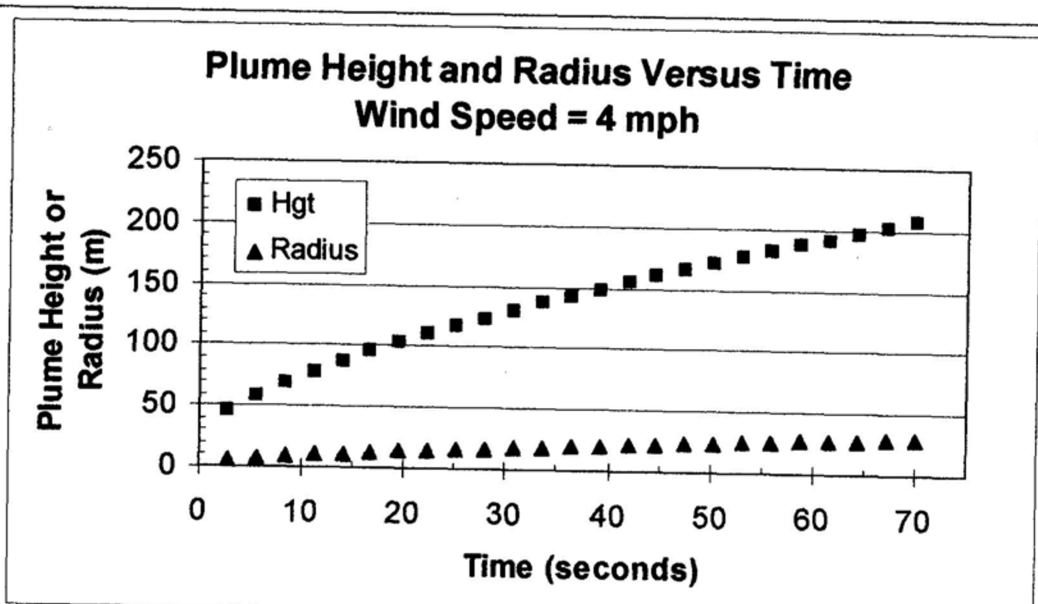


Figure 1 Plume Height and Radial Growth Versus Time, GE LM6000 Combustion Turbine

Plume Turbulence Analysis

In the momentum-dominated phase of plume rise, the turbulence in the plume is determined by the rate of plume growth. This rate of plume growth is determined by the entrainment velocity, or the velocity at which the edge of the plume expands outward. This velocity governs the rate at which ambient air is mixed into the plume, dissipating both momentum and buoyancy in the plume and governing plume internal turbulence and plume rise. Large entrainment velocities are associated with high levels of plume turbulence relative to ambient conditions.

An estimate of the average entrainment velocities into the plume can be obtained from the time history of the plume rise and growth. We estimate the mean vertical entrainment velocity as the change in height with time ($\Delta z/\Delta t$) of a segment of the plume. The mean radial (horizontal) entrainment velocity can be estimated as the change in plume radius with time ($\Delta r/\Delta t$) of a segment of the plume. Figure 2 presents a plot of the estimated radial and vertical entrainment velocities for a single plume. The peak entrainment velocities occur immediately after release near the stack and are 2 m/s for the radial and 13 m/s for the vertical components. By the time of transition to buoyancy domination (8 seconds after release), the estimated radial and vertical components of the entrainment velocity have fallen to less than 0.6 m/s and 4 m/s, respectively.

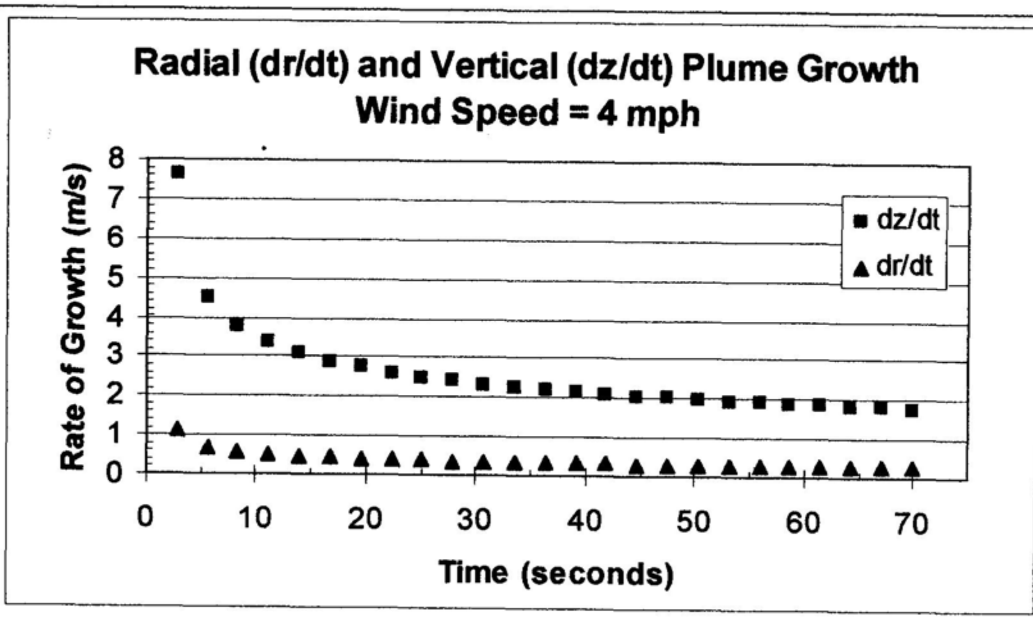


Figure 2 Estimated Radial and Vertical Entrainment Velocities, GE LM6000 Combustion Turbine

By comparison, naturally occurring desert dust devils and thermals have observed velocity fluctuations of the same or greater magnitude. Kaimal and Businger (1970) present measurements made of wind speeds associated with the passage of dust devils and thermals. During passage of one thermal (convective plume) the observed change in horizontal and vertical wind speed in approximately one second was 2 m/s and 3 m/s respectively. During passage of moderate size dust devil, the peak one second changes in horizontal and vertical wind speeds were approximately 10 m/s and 6 m/s, respectively.

Immediately upon release from the stack, the vertical and radial entrainment velocities of the plume are comparable to those observed in dust devils. By the time the momentum-dominated phase of plume rise ends after less than 8 seconds, the entrainment velocities are well below those observed in dust devils and thermals.

Conclusions

ENSR concludes that the thermal plumes from the Riverside ERC do not pose an undue hazard to aircraft operations at the nearby Riverside Municipal Airport. This conclusion is based on four lines of reasoning.

1. Peak Plume Turbulence is Equal to or Less than Natural Turbulence in Dust Devils

Internal plume and dust devil turbulence are a function of the entrainment velocity (plume) and velocity shear (dust devil) within the plume or dust devil. Except for the first second or two after release, the turbulence in a plume will be less than that produced by naturally occurring dust devils and thermals. Consequently, turbulence in the plume is expected to be equal to or less than the turbulence in dust devils and thermals. Therefore, the thermal plumes from the proposed facility should pose no greater threat to aviation than the dust devils and thermals that are common in the desert portion of Riverside County year round.

2. Time for an Aircraft to Pass Through the Plume is Small

From Table 1, the horizontal radius of the emitted vertical plume is less than 9 meters after 8 seconds and this occurs at a height above ground of approximately 68 meters. At a minimum air speed of 100 knots (approximately 51 m/s), the time for an aircraft to pass through a plume 18 m in diameter is less than 0.4 seconds. At higher speeds, the transit time will be even lower. At lower heights, the transit time is smaller because of a smaller plume. However, at lower heights, ground objects pose more of a hazard to aviation than does turbulence in the CTG plume.

3. Plume Turbulence Is Near Ambient Levels when the Plume Reaches Runway 16/34

The CTG stacks are located approximate 100 meters west of the extension of Runway 16/34 to the north. At the representative daytime wind speed of 4 mph (1.8 m/s), the travel time for a plume to reach the flight path of the runway is approximately 55 seconds. By this time, the original turbulence in the plume has dissipated, plume turbulence is essentially governed by ambient turbulence levels, and the plume poses no hazard to aviation.

4. Power Plant Plumes Do Not Pose a Significant Risk to Aircraft During Air Pollution Studies

There is a long record of the uneventful sampling of power plant plumes by aircraft during air pollution studies. During these programs, aircraft (typically fixed wing) purposely fly through a power plant plume in order to characterize the initial chemical, physical, and thermodynamic properties of the plume upon release and the time history of changes in these properties as the plume disperses downwind. While some turbulence is experienced during transits of a plume close to the stack, the observed levels of the turbulence have not prevented the safe completion of the sampling protocols (Tombach, 1998).

References

EPA, 1995. "User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II, Description of Model Algorithms", EPA-454/B-95-003b, Office of Air Quality Planning and Standards, Research Triangle Park, NC, September.

G.A. Briggs 1975a. *Lectures on Air Pollution and Environmental Impact Analysis*, Chapter 3., Section 7, pg 96 (equation 48), American Meteorological Society, Boston, MA, 1995.

G.A. Briggs 1975b. *Lectures on Air Pollution and Environmental Impact Analysis*, Chapter 3., Section 3.1, pg 77 (equation 44), American Meteorological Society, Boston, MA, 1995.

Kaimal, J.C., and J.A. Bisinger, 1970. "Case Studies of a Convective Plume and a Dust Devil', *Journal of Applied Meteorology*, 8:612-620.

Tombach, I, 1998. Personal communication with Ivar Tombach, Ph.D., QEP, ENSR, March.